

<b>RDT&amp;E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)</b>								DATE <b>February 1999</b>		
BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>						
COST (\$ In Thousands)	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	70,027	58,114	51,512	56,629	55,554	55,252	62,867	66,653	Continuing	Continuing
1123 Manpower, Personnel, and Training	18,633	13,805	9,041	10,287	14,156	14,690	15,052	15,561	Continuing	Continuing
1710 Deployment and Logistics Technologies	4,700	3,173	5,851	5,994	4,982	3,484	5,365	5,702	Continuing	Continuing
1900 Environmental Quality Technology	4,230	3,637	0	0	0	0	0	0	TBD	TBD
7184 Crew Technology	24,419	25,352	28,052	29,724	25,499	26,001	31,593	34,144	Continuing	Continuing
7755 Aircrew Physiology Technology	4,086	0	0	0	0	0	0	0	TBD	TBD
7757 Directed Energy Bioeffects	13,959	12,147	8,568	10,624	10,917	11,077	10,857	11,246	Continuing	Continuing
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

NOTE: The decrease between FY 1998 and FY 1999 is due to elimination of Aircrew Physiology Technology (Project 7755) and significant reductions to Deployment and Logistics Technologies (Project 1710) and Manpower, Personnel, and Training (Project 1123). The decrease between FY 1999 and FY 2000 is due to the elimination of Environmental Quality Technology (Project 1900) and reductions to Manpower, Personnel and Training (Project 1123) for intelligent computer adaptive instruction and knowledge-based technologies. Due to restructuring within the Air Force Research Laboratory, the environmental noise portion of Project 7757 moved to Project 7184 in FY 1999, studies in support of Distributed Mission Training will move from Project 7184 to Project 1123 in FY 2000, and the toxicology hazards research program will move from Project 7757 to Project 1710 in FY 2000.

(U) A. **Mission Description:** This Applied Research program establishes technology feasibility and develops the technology base for Air Force human interface needs required for weapon systems, operational readiness, and environmental quality. The program addresses crew systems; manpower, personnel, training, and logistics; aerospace physiology investigation; occupational and environmental safety; and environmental compliance, site remediation, and pollution prevention. Crew systems technologies increase the performance of humans in weapon systems operation by improving aircrew life support systems, man-machine integration (to include aircraft information display systems), and protection from dynamic forces (acceleration/escape/windblast). Manpower, personnel, training, and logistics technologies focus on reducing manpower required to operate and support weapon systems by: providing more effective methods to classify, train, and retain warfighters and their support force; modeling human cognitive functioning on complex tasks to enhance operational performance; increasing weapon systems supportability and affordability; and improving wartime logistics planning. Occupational and environmental health and safety technologies support deployment, operation, and maintenance of Air Force weapon systems

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## RDT&amp;E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE  
February 1999

BUDGET ACTIVITY

**2 - Applied Research**

PE NUMBER AND TITLE

**0602202F Human Effectiveness Applied Research**

by developing: occupational and operational exposure safety guidelines for militarily relevant electromagnetic radiation's and toxicants; detection, control, reduction, and disposal of pollutants from Air Force operations; and cleaning up contaminated Air Force sites. Payoff from these technology development efforts is to improve combat effectiveness by expanding all parameters defining operational performance limits.

(U) **B. Budget Activity Justification:** This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies. This Applied Research program establishes technology feasibility and develops the technology base for Air Force human interface needs required for weapon systems, operational readiness, and environmental quality.

(U) **C. Program Change Summary (\$ in Thousands):**

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>Total Cost Cont</u>
(U) Previous President's Budget/FY 1999 PB	72,118	60,805	55,802	57,661	
(U) Appropriated Value	76,102	60,805			
(U) Adjustments to Appropriated Value					
a. Congressional/General Reduction	-2,641	-2,691			
b. SBIR	-1,164				
c. Omnibus/Other Above Threshold Reprogrammings	-2,117				
d. Below Threshold Reprogrammings	-153				
(U) Adjustments to Budget Year Since FY 1999 PB			-4,290	-1,032	
(U) Current Budget Submit/FY 2000 PB	70,027	58,114	51,512	56,629	Cont

(U) Significant Program Changes: Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&T) Program.

FY 1999: \$937 identified as a source for SBIR.

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<b>RDT&amp;E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)</b>								DATE <b>February 1999</b>		
BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>				PROJECT <b>1123</b>		
COST (\$ In Thousands)	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
1123 Manpower, Personnel, and Training	18,633	13,805	9,041	10,287	14,156	14,690	15,052	15,561	Continuing	Continuing

**(U) A. Mission Description:** This project develops and evaluates new methods and technologies in support of Air Force training and education requirements in a variety of specific areas, including: aircrew training; technical training; logistics training; mission rehearsal; training in support of complex decision making; space operations training; information warfare training; and warfare readiness training. It investigates the spectrum of new and advanced training and education technologies for optimal ways to determine needs and deficiencies, design and implement training, and to evaluate training effectiveness. It develops and evaluates specific training systems, desktop tutors, courseware development tools and technologies, assessment methodologies, and simulation-based systems to determine how to achieve maximum learning effectiveness for specific needs at minimum cost. This project will contribute to a more highly trained and flexible cadre of personnel and reduce the cost of maintaining crew, aircraft, and support personnel readiness. This Applied Research program develops technologies to increase operational readiness by providing more effective methods and approaches to classify, assign, train, assess, and retain personnel. This program focuses on reducing the manpower required to operate and support weapon systems and on improving the effectiveness of the operators, maintainers, and other support personnel for those systems. Note: Intelligent computer adaptive instruction and knowledge-based technologies will be eliminated in FY 2000.

(U) FY 1998 (\$ in Thousands):

- (U) \$ 9,717      Developed technologies required to create an integrated Distributed Mission Training environment by assessing concepts and trainers/simulators, evaluating simulation-based mission preparation and rehearsal effectiveness, and assessing alternative training strategies using eye tracking technology.
- (U) \$ 4,725      Developed knowledge-based and adaptive training technologies including representation/student modeling schemes and associated instructional authoring technologies, intelligent/adaptive training and instructional design technologies, and student assessment and evaluation technologies.
- (U) \$ 4,191      Developed and transitioned technologies to select, classify, and assess Air Force personnel and structure DoD jobs to maximize performance and mission accomplishment.
- (U) \$18,633      Total

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<p>(U) <u>FY 1999 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> <li>- (U) \$10,581 Develop technologies required to enhance the integrated Distributed Mission Training (DMT) environment by incorporating space and information operations systems and by developing mission rehearsal training technologies, a more representative electronic combat environment, and High Level Architecture (HLA) compliant systems.</li> <li>- (U) \$ 900 Develop Air Force training guidelines, instructional scenarios, and techniques for use in Air Force aircrew, space, and information operations mission training.</li> <li>- (U) \$ 700 Refine intelligent computer adaptive instruction authoring system based on knowledge representation/student modeling technologies and knowledge-based technologies for curriculum planning and media selection.</li> <li>- (U) \$ 1,400 Develop concept and technologies to enable a warfare operations center by creating performance specifications for a seamless, integrated information system consisting of mission planning, automated brief/debrief, simulation, academics, weapon systems, and Command, Control, and Information systems.</li> <li>- (U) \$ 224 Identified as a source for SBIR.</li> <li>- (U) \$13,805 Total</li> </ul> <p>(U) <u>FY 2000 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> <li>- (U) \$ 5,515 Develop technologies required to enhance the integrated DMT environment by developing space and information operations simulators/trainers, and representation, human systems, and interconnection technologies.</li> <li>- (U) \$ 2,600 Develop Air Force training guidelines, instructional scenarios, and techniques by transitioning combat aerial training technologies and performance measurement systems into aircrew, space, and information operations environments.</li> <li>- (u) \$ 926 Develop concept and technologies to enable a warfare operations center by integrating the command and control systems of the warfare operations center with the distributed mission training environment.</li> <li>- (U) \$ 9,041 Total</li> </ul>		
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(U) FY 2001 (\$ in Thousands):

- (U) \$ 7,227 Develop technologies required to enhance the integrated Distributed Mission Training environment by developing space and information operations simulators/trainers, and representation, human system, and interconnection technologies.
- (u) \$ 1,200 Develop Air Force training guidelines, instructional scenarios, and techniques by transitioning combat aerial training technologies and performance measurement systems into aircrew, space, and information operations environments.
- (U) \$ 1,860 Develop concept and technologies to enable a warfare operations center by integrating the command and control systems of the warfare operations center with the distributed mission training environment.
- (U) \$ 10,287 Total

(U) **B. Project Change Summary - Description of Significant Changes:** Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&T) Program.

(U) **C. Other Program Funding Summary:**

(U) Related Activities:

- (U) PE 0602233N, Mission Support Technology: Personnel, Training, and Simulation Technology Area.
- (U) PE 0602716A, Human Factors Engineering Technology Development.
- (U) PE 0602727A, Non-System Training Devices Technology.
- (U) PE 0602785A, Manpower, Personnel, and Training Technology.
- (U) PE 0603106F, Logistics Systems Technology.
- (U) PE 0603227F, Personnel, Training, and Simulation Technology.
- (U) PE 0604227F, Distributed Mission Training (DMT).
- (U) PE 0604243F, Manpower, Personnel, and Training Development.
- (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy:** Not Applicable.

(U) **E. Schedule Profile:** Not Applicable.

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BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>				PROJECT <b>1710</b>		
COST (\$ In Thousands)	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
1710 Deployment and Logistics Technologies	4,700	3,173	5,851	5,994	4,982	3,484	5,365	5,702	Continuing	Continuing

**(U) A. Mission Description:** This project investigates and researches technologies to support the enhancement of the deployment and sustainment technologies critical to the goals and requirements of Agile Combat Support and Air Expeditionary Force operations. The research focuses on technologies with the potential to: reduce the time required for units to plan, pack up, and deploy; reduce airlift requirements while enhancing deployed capability; enhance sustainment of deployed forces in contingency environments; improve logistics support for both combat and peacetime operations; and develop toxicological tools and technology to minimize the health risks and mission impact to DoD personnel from exposure to hazardous chemicals while also reducing weapon system life cycle cost.

**(U) FY 1998 (\$ in Thousands):**

- (U) \$ 831 Explored and defined advanced logistics technology concepts in on-orbit servicing, remote diagnostics, and logistics models for improved support of space operations to increase the availability and flexibility of space assets.
- (U) \$1,269 Explored technology options to improve agile combat support capabilities by conducting trade studies on advanced visualization presentation capabilities for use by maintenance technicians in advanced research projects, and evaluated speech intelligibility of synthetic voice software packages for use in depots and on flightlines.
- (U) \$2,600 Adapted and refined information technologies to enhance logistics and deployment planning capabilities by including software tools and architectures that added high levels of intelligence to logistics information system interfaces and databases for more effective use in rapid response contingency and deployed operations.
- (U) \$4,700 Total

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		PROJECT <b>1710</b>
<div style="margin-bottom: 10px;">             (U) <u>FY 1999 (\$ in Thousands):</u> <ul style="list-style-type: none"> <li>– (U) \$ 658 Explore and define highly reliable, low footprint, multi-function, rapid on-load/off-load, and ground movement technology concepts which will increase deployment speed and decrease airlift requirements in support of agile combat support and rapid global mobility goals.</li> <li>– (U) \$1,062 Explore and develop technology options to improve agile combat support capabilities by assessing alternative input devices, such as electro-oculographic and electromyographic capabilities, to be used in various maintenance environments which are loud (prohibiting voice control capability), and requiring free hands (prohibiting manual control). Investigate advanced user interfaces to support wing level logistics decision making to enhance response time and unit capability in Air Expeditionary Force operations.</li> <li>– (U) \$1,419 Adapt and refine information technologies to enhance logistics and deployment planning capabilities by defining and evaluating advanced knowledge representation schemes and computational linguistics methods to automatically extract maintenance manual information for weapon systems design data.</li> <li>– (U) \$ 34 Identified as a source for SBIR.</li> <li>– (U) \$3,173 Total</li> </ul> </div> <div>             (U) <u>FY 2000 (\$ in Thousands):</u> <ul style="list-style-type: none"> <li>– (U) \$ 500 Develop interoperable and intermodal containerization and pallet optimization technologies that will significantly streamline cargo handling during on-load/off-load operations at aerial ports and deployed locations to directly support air expeditionary forces.</li> <li>– (U) \$3,051 Explore and develop advanced logistics technology options and perform specialized technical research to support large-scale advanced technology development programs. Identify diagnostic strategies and develop initial algorithms to support the advanced prognostic/diagnostic program which will improve and reduce aircraft down time. Develop enabling technology for innovative software architectures for the representation of human behavior in synthetic environments to increase the fidelity of wargame simulations and decrease the number of required wargame-support personnel.</li> <li>– (U) \$2,300 Develop and expand capabilities of robust bio-technology force protection tools to assess real-world mixed operational chemical exposures. Integrate biological assay results using novel mathematical models to provide Air Expeditionary Force commanders with near-real-time prediction of adverse human health and mission performance impact.</li> <li>– (U) \$5,851 Total</li> </ul> </div>		
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(U) FY 2001 (\$ in Thousands):

- (U) \$ 500 Develop deployable, cargo-compartment-sized containers that will significantly decrease the time required to set up operations at deployed locations, thereby decreasing deployment times and increasing sortie generation rates. Develop point of use delivery and extraction technologies to decrease airlift vulnerability and increase delivery and retrograde pipeline speed during operational deployments.
- (U) \$2,799 Explore and develop advanced logistics technology options to further enhance large-scale advanced development programs. Investigate technology concepts to extend the Distributed Mission Training capability into the maintenance and logistics areas to improve combat capability by enhancing technical performance. Develop innovative software architectures for automated transformation of weapon system engineering data into procedural maintenance instructions to drastically reduce technical order development costs.
- (U) \$2,695 Demonstrate and continue to develop and evaluate force protection technologies in the form of biological assays and mathematical predictive models to assess operational chemical exposures and to provide Air Expeditionary Force commanders with near-real-time predictions of adverse human health mission performance impact. Initiate studies using deployment field samples to align and validate model predictions.
- (U) \$5,994 Total

(U) **B. Project Change Summary - Description of Significant Changes:** Not Applicable.

(U) **C. Other Program Funding Summary:**

(U) Related Activities:

- (U) PE 0602233N, Mission Support Technology: Personnel, Training, and Simulation Technology Area.
- (U) PE 0602716A, Human Factors Engineering Technology Development.
- (U) PE 0603106F, Logistics Systems Technology.
- (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy:** Not Applicable.

(U) **E. Schedule Profile:** Not Applicable.

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BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>				PROJECT <b>1900</b>		
COST (\$ In Thousands)	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
1900 Environmental Quality Technology	4,230	3,637	0	0	0	0	0	0	TBD	TBD
<p><b>(U) A. Mission Description:</b> This project develops technologies to characterize the chemistry of Air Force-generated pollutants and toxic materials, assesses their interaction with the environment, and develops reduction/destruction and control techniques with the objective to reduce the cost and increase the effectiveness of technologies that protect the environment; emphasis is placed on pollution prevention technologies. New Air Force fuels and chemicals are analyzed to identify and prevent possible environmental problems. Materials are investigated and new processes explored to assess and reduce environmental risks. Monitoring and control technologies are developed for Air Force operations by using novel instrumentation, characterization, and modeling techniques.</p> <p><b>(U) FY 1998 (\$ in Thousands):</b></p> <ul style="list-style-type: none"> <li>– (U) \$ 885 Developed technologies and design criteria for improved monitoring, characterization, and assessment of risks to the environment posed by Air Force activities by developing a database of the rates of photochemical reactions of Air Force solvent vapor and new fuels, and completed studies proving natural biodegradation of hydrocarbon contaminants is an acceptable method of treatment.</li> <li>– (U) \$1,796 Developed affordable technology capable of regenerating activated carbon filters in-place to control air polluting emissions from Air Force industrial processes and investigated gas phase by-products of cold, plasma-induced chemical reactions to determine how to produce an exhaust stream that when discharged, complies with Clean Air Act Amendments.</li> <li>– (U) \$1,549 Developed chemical reactors to convert liquid wastes and energetic materials from Air Force operations to non-hazardous products.</li> <li>– (U) \$4,230 Total</li> </ul>										
<div style="display: flex; justify-content: space-between; padding: 10px;"> <span>Project 1900</span> <span>Page 9 of 21 Pages</span> <span>Exhibit R-2A (PE 0602202F)</span> </div>										

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<p>(U) <u>FY 1999 (\$ in Thousands)</u>:</p> <ul style="list-style-type: none"> <li>- (U) \$ 927 Investigate and develop environmentally acceptable replacement materials and processes to reduce the cost of weapon systems sustainment by developing new selection criteria for Air Force industrial solvents and fuels, and by characterizing the air quality effects of Air Force volatile materials.</li> <li>- (U) \$ 893 Develop environmental instrumentation for chemical detection and monitoring and process controls by: identifying and correcting unnecessary Air Transport and Dispersion (ATD) launch holds and reducing liability risks; developing techniques to accurately characterize Air Force-generated particulate matter (PM); and developing innovative instrumentation to detect chlorinated solvents, explosives, and other Air Force-monitored chemicals.</li> <li>- (U) \$1,759 Reduce weapon systems sustainment costs and enhance Air Force readiness by: developing engineering tools to isolate and synthesize enzymes for perchlorate chlorate and chlorite reduction; converting propellant from missiles and rockets to benign compounds; characterizing strategies for energy generation and water recovery from waste treatment systems; enhancing DoD capability to contain and control regulated emissions from depainting and other corrosion-control operations; and studying environmental interactions of advanced fuels and solvents.</li> <li>- (U) \$ 58 Identified as a source for SBIR.</li> <li>- (U) \$3,637 Total</li> </ul> <p>(U) <u>FY 2000</u>: Not Applicable.</p> <p>(U) <u>FY 2001</u>: Not Applicable.</p>		
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<p>(U) <b>B. <u>Project Change Summary - Description of Significant Changes:</u></b> Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&amp;T) Program.</p> <p>(U) <b>C. <u>Other Program Funding Summary:</u></b></p> <p>(U) <u>Related Activities:</u></p> <ul style="list-style-type: none"> <li>- (U) PE 0601102F, Defense Research Sciences.</li> <li>- (U) PE 0602102F, Materials.</li> <li>- (U) PE 0602203F, Aerospace Propulsion.</li> <li>- (U) PE 0603112F, Advanced Materials for Weapon Systems.</li> <li>- (U) PE 0603211F, Aerospace Structures.</li> <li>- (U) PE 0603723F, Environmental Engineering Technology.</li> <li>- (U) PE 0603716D, Strategic Environmental Research and Development Program.</li> <li>- (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.</li> </ul> <p>(U) <b>D. <u>Acquisition Strategy:</u></b> Not Applicable.</p> <p>(U) <b>E. <u>Schedule Profile:</u></b> Not Applicable.</p>		
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BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>				PROJECT <b>7184</b>		
COST (\$ In Thousands)	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
7184 Crew Technology	24,419	25,352	28,052	29,724	25,499	26,001	31,593	34,144	Continuing	Continuing

**(U) A. Mission Description:** This project develops the technology required to improve human performance, protection, and survivability in operational environments. This is accomplished by defining the physical parameters, capabilities, and limits of systems operators; determining human responses to operational stresses such as noise, impact, vibration, sustained acceleration, spatial disorientation, altitude, workload, and sustained operations; and optimizing the human-machine interface. The project produces human-centered design criteria, guidelines, and automated design tools for the development of effective technologies for information display, team communications, crew scheduling and fatigue management, control interfaces, crew station layout and functional integration, emergency escape, crash protection, aircrew oxygen systems, acceleration protection, and aircrew life support.

**(U) FY 1998 (\$ in Thousands):**

- (U) \$ 1,710      Developed unobtrusive, reliable predictors of human system safety and effectiveness, including metrics for crew workload, situational awareness, and physical accommodation. Established workload and performance baselines in simulators. Demonstrated performance metrics in joint field exercises. Completed cockpit aircrew accommodation surveys for 50 percent of Air Force aircraft types and completed 50 percent U.S. data collection under a multi-national, whole-body three-dimensional size survey.
- (U) \$ 4,454      Demonstrated system design technologies that integrate human factors data for workstations to accommodate an expanded crew population and demonstrated an effective crew workplace integration of DoD common surveillance automatic target recognition technology in operational field test.
- (U) \$ 6,329      Developed visual display technology for improved human-machine interfaces, concentrating on sensor-augmented cockpit technology, including baseline human visual performance needed for future helmet displays and wide field-of-view night vision displays; standardized test methods for night vision devices and aircraft visual transparencies.
- (U) \$ 2,775      Continued to develop improved audio technologies for enhanced human-system interfaces. Developed technologies to measure and predict the effects of human auditory responses, and provided voice communication criteria for selected Air Force weapon systems and base operations to improve situational awareness, enhance operator effectiveness, and reduce workload.
- (U) \$ 5,228      Developed and evaluated aircrew life-support and performance technologies including oxygen generation, life support, and high-altitude protection technologies; developed in-flight spatial disorientation training technologies; developed strength conditioning regimens for improved acceleration tolerance; and determined effects of multi-axis accelerations on aircrew piloting performance.
- (U) \$ 3,067      Developed technologies to assess aircrew safety during high-speed escape for use in designing and evaluating efficacy and safety of ejection seats, helmet systems, and other personal protection equipment.
- (U) \$ 856      Developed fatigue models and demonstrated concept for integrating fatigue effects into campaign-level models for aircrew sustained operations.
- (U) \$24,419      Total

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<p>•</p> <p>(U) <u>FY 1999 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> <li>– (U) \$ 2,340 Continue to develop unobtrusive, reliable predictors of human system effectiveness based on crew workload and situational awareness. Finish international validation and select predictive workload model to advance technology for human performance design assessment and eliminate crew task overload. Validate model and metrics with simulation of Predator Uninhabited Air Vehicle control station. Complete cockpit aircrew accommodation evaluations for Air Force inventory aircraft. Complete U.S. part of international whole-body three-dimensional size survey for new design tool.</li> <li>– (U) \$ 5,641 Continue to develop system design technologies that integrate human factors data for workstations by integrating an on-line data system and related computer-aided design templates, by developing network models to streamline the sharing of data among intelligence analysts and command centers, and by initiating development of multi-sensory adaptive control as a new design technology.</li> <li>– (U) \$ 7,590 Continue to develop visual display technology for improved human-machine interfaces and demonstrate adaptive interface technology, including integrated display and information processing standards; design alternatives for next generation helmet-mounted sight/displays, ejection-safe, panoramic night vision goggles with external sensor inputs to enhance night operations; and a pilot-vehicle interface that adapts to pilot physiological and behavioral state.</li> <li>– (U) \$ 1,775 Continue expansion of audio technologies to establish new information management methods to improve operator performance in high workload environments.</li> <li>– (U) \$ 1,580 Continue aircrew life support and performance research including the effect of high G on pilot color perception and the ability to discern color cues on head-up and head-down displays.</li> <li>– (U) \$ 3,606 Develop tolerance criteria for assessing effects of forces experienced during escape, sustained, and transient accelerations on crew safety and performance while using head/helmet mounted equipment.</li> <li>– (U) \$ 2,300 Improve integrated mission rehearsal training technologies for aircrew and battlestaff in simulated and field extended/continued operations.</li> <li>– (U) \$ 95 Support the joint Air Force/Defense Advanced Research Projects Agency Uninhabited Combat Air Vehicle (UCAV) program.</li> <li>– (U) \$ 425 Identified as a source for SBIR.</li> <li>– (U) \$25,352 Total</li> </ul>		
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BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>	PROJECT <b>7184</b>
<p>(U) <u>FY 2000 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> <li>– (U) \$ 4,254 Continue to develop unobtrusive, reliable predictors of human performance by extending workload metric technology to include a near real-time classification of overload, and apply to next-generation multi-sensory fighter cockpit with high-fidelity immersive simulation under joint Air Force-France-United Kingdom agreements. Demonstrate performance metric technology in design evaluation of advanced Predator Uninhabited Air Vehicle control station. Complete NATO part of multi-national whole-body three-dimensional survey, and begin to validate cockpit accommodation model.</li> <li>– (U) \$ 3,030 Continue to develop system design technologies that integrate human factors including network models to streamline the sharing and synchronization of operational performance data among intelligence analysts and command centers, and to overcome the data overload problem facing multi-place air battle staff operations.</li> <li>– (U) \$ 3,861 Advance crew system design technologies for airborne and ground control stations, and begin to develop a new human performance model technology to enable rapid affordable crew station design. Introduce the ability to define and visualize the human operator's cognitive, perceptual, and physical performance in the operational task environment.</li> <li>– (U) \$ 4,469 Continue to develop visual display technology concentrating on next generation helmet trackers, display visual performance criteria, on-board/off-axis weapon cueing, sensor display definitions, and monochrome active-matrix organic light-emitting-diode for helmet display; assess anti-reflection visors and ejection-safe, panoramic night vision goggles (PNVGs) with head-up display insert. Develop comprehensive transparency design guidelines.</li> <li>– (U) \$ 2,349 Develop and demonstrate integrated three-dimensional audio, active noise reduction, voice control, and voice activated switch technologies in a low-cost, high reliability, reconfigurable aircraft audio interface system to enhance performance and reduce workload. Continue to explore audio information management for improvement of operator performance in high-workload/high-noise environments and audio enhancements for improvements in remote threat detection. Demonstrate reduced cost noise monitoring systems for environmental compliance.</li> <li>– (U) \$ 5,489 Continue development of injury criteria and technologies for improved aircrew and support personnel protective equipment focusing on safe accommodation of the full aircrew population. Develop criteria for human performance in a high sustained acceleration environment.</li> <li>– (U) \$ 3,600 Continue to provide human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Uninhabited Combat Air Vehicle (UCAV) program.</li> <li>– (U) \$ 1,000 Conduct international cooperative effort with Australia for Virtual Air Commanders.</li> <li>– (U) \$28,052 Total</li> </ul>		
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BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>	PROJECT <b>7184</b>
<p>(U) <u>FY 2001 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> <li>– (U) \$ 4,756 Continue to develop unobtrusive, reliable predictors of human performance by validating F-15E crew workload/operational weapon system and tactics data. Initiate development of on-line, intelligent physical accommodation information system for crew system and personal equipment design. Complete workload classification algorithm and incorporate into initial multi-sensory adaptive control interface for uninhabited air systems, for both improved crew effectiveness and mission success rate.</li> <li>– (U) \$ 3,418 Continue to develop system design technologies that integrate human factors including network models to streamline the sharing and synchronization of operational performance data among intelligence analysts and command centers, and to overcome the data overload problem facing multi-place air battle staff operations. Simulate command center operations using human-centered data interface and demonstrate ability to process and deploy critical information to maximize team performance.</li> <li>– (U) \$ 4,056 Continue to develop integrated human performance models and analysis tools to advance effective/rapid/affordable crew system design technologies for airborne and ground control stations; demonstrate with analytical experiments.</li> <li>– (U) \$ 5,000 Continue to develop visual display technology including integrated display and information processing standards for targeting helmet sight/display, design alternatives for lightweight helmet sight/display using eye line-of-sight cueing, and demonstrate monochrome active-matrix organic light-emitting-diode for helmet display. Perform ejection risk assessment for panoramic night vision goggles, and develop and verify visual performance models for windscreen optical parameters.</li> <li>– (U) \$ 2,648 Continue development and flight demonstration of reconfigurable aircraft audio interface system for enhanced performance and reduced workload. Explore active noise reduction and active vibration reduction concepts for mitigation of noise and vibration hazards for aircrews and Air Force personnel. Develop technology to assess and reduce adverse impacts of aircraft noise and sonic booms produced by Air Force operations.</li> <li>– (U) \$ 5,151 Develop advanced restraint system technologies using defined injury criteria to ensure safety of all aircrew during aircraft and other vehicle operations, crashes, and emergency escape. Develop criteria for human performance in a high sustained acceleration environment.</li> <li>– (U) \$ 3,195 Continue to provide human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Uninhabited Combat Air Vehicle (UCAV) program.</li> <li>– (U) \$ 1,500 Continue international cooperative effort with Australia for Virtual Air Commanders.</li> <li>– (U) \$29,724 Total</li> </ul>		
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(U) **B. Project Change Summary - Description of Significant Changes:** Not Applicable.

(U) **C. Other Program Funding Summary:**

(U) Related Activities:

- (U) PE 0602201F, Aerospace Flight Dynamics.
- (U) PE 0602204F, Aerospace Sensors.
- (U) PE 0602702F, Command, Control, and Communications.
- (U) PE 0603205F, Aerospace Vehicle Technology.
- (U) PE 0603227F, Personnel, Training and Simulation Technology.
- (U) PE 0603231F, Crew Systems and Personnel Protection Technology.
- (U) PE 0603245F, Flight Vehicle Technology Integration.
- (U) PE 0604227F, Distributed Mission Training (DMT).
- (U) PE 0604703F, Aeromedical/Casualty Care Systems Development.
- (U) PE 0604706F, Life Support Systems.
- (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy:** Not Applicable.

(U) **E. Schedule Profile:** Not Applicable.

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BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>					PROJECT <b>7755</b>	
COST (\$ In Thousands)	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
7755    Aircrew Physiology Technology	4,086	0	0	0	0	0	0	0	TBD	TBD
<p>(U) <b>A. Mission Description:</b> This project enhances aircrew effectiveness by developing an understanding of: (1) conditions affecting aircrew selection and retention; (2) methods of early disease detection; (3) impact of asymptomatic disease on aircrew performance; (4) therapeutic drug effects on flight safety; and (5) physiological factors affecting operational readiness and effectiveness.</p> <p>(U) <u>FY 1998 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> <li>– (U) \$ 883        Completed development of and evaluation for aircrew vision enhancement technologies for both day and night air combat.</li> <li>– (U) \$2,823      Completed development of methods to identify and remediate physiological impairments arising from flying high performance aircraft.</li> <li>– (U) \$ 380        Conducted and completed expanded physical fitness test battery and fire fighter physical fitness programs.</li> <li>– (U) \$4,086      Total</li> </ul> <p>(U) <u>FY 1999:</u> Not Applicable.</p> <p>(U) <u>FY 2000:</u> Not Applicable.</p> <p>(U) <u>FY 2001:</u> Not Applicable.</p>										

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BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>	
		PROJECT <b>7755</b>
<p>(U) <b>B. <u>Project Change Summary - Description of Significant Changes:</u></b> Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&amp;T) Program.</p> <p>(U) <b>C. <u>Other Program Funding Summary:</u></b></p> <p style="margin-left: 40px;">(U) <u>Related Activities:</u></p> <ul style="list-style-type: none"> <li>- (U) PE 0603231F, Crew Systems and Personnel Protection Technology.</li> <li>- (U) PE 0604703F, Aeromedical/Casualty Care Systems Development.</li> <li>- (U) PE 0604706F, Life Support Systems.</li> <li>- (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.</li> </ul> <p>(U) <b>D. <u>Acquisition Strategy:</u></b> Not Applicable.</p> <p>(U) <b>E. <u>Schedule Profile:</u></b> Not Applicable.</p>		
<div style="display: flex; justify-content: space-between; margin-top: 400px;"> <span>Project 7755</span> <span>Page 18 of 21 Pages</span> <span>Exhibit R-2A (PE 0602202F)</span> </div>		

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BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>				PROJECT <b>7757</b>		
COST (\$ In Thousands)	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
7757 Directed Energy Bioeffects	13,959	12,147	8,568	10,624	10,917	11,077	10,857	11,246	Continuing	Continuing

**(U) A. Mission Description:** This project enables the safe operational use of Air Force directed energy weapon systems through technology development related to the biological effects of electromagnetic radiation used in, or resulting from, Air Force operations. The project identifies and mitigates the biological effects of exposure to radio frequency and microwave radiation, lasers, broad band munitions, and ultrawide band pulsed fields by addressing areas such as safety, risk assessment, mission planning and countermeasures in combat, and non-lethal applications for special operations, missions other than war, and peacekeeping operations. This project provides technical consultative support to other DoD programs to assess and counter optical and radio frequency hazards and threats.

**(U) FY 1998 (\$ in Thousands):**

- (U) \$ 3,533      Conducted laser optical bioeffects research to enable countermeasures for optical hazards/threats by initiating probabilistic risk approach to safety for high-energy laser systems and laser system safety standards.
- (U) \$ 4,683      Conducted radio frequency radiation (RFR) bioeffects research to enable safe exploitation of lethal and non-lethal directed energy weapons, advanced communications systems, and radar by initiating RFR cancer promotion study and promulgating NATO RFR Standardization Agreement.
- (U) \$ 4,996      Developed health-based risk management process for Air Force operational fuels and weapon system fire suppression agents. Demonstrated feasibility of rapid screening tool for toxic exposure hazard assessment applicable to a wide range of deployment locations.
- (U) \$ 747        Developed technology to reduce adverse impacts of aircraft noise and sonic booms by demonstrating miniaturized affordable sonic boom monitor, conducting a joint study with the Navy to model noise propagation over water, and demonstrating radar tracking storage technology for noise analysis.
- (U) \$13,959      Total

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(U) FY 1999 (\$ in Thousands):

- (U) \$ 4,209 Conduct laser optical bioeffects research to enable countermeasures for optical hazards/threats by initiating development of guidelines for high energy laser safety and low energy systems for non-lethal use, and refining biological effects models to assess combat vulnerability to emerging optical threats.
- (U) \$ 5,578 Conduct bioeffects research to enable safe exploitation of lethal and non-lethal directed energy weapons, advanced communications systems, and radar by transitioning tri-Service High-Power Microwave (HPM) Ocular Hazards Study results to DoD and developing/providing data for policy review of Active Denial Technology (ADT) non-lethal weapon.
- (U) \$ 2,070 Develop and evaluate robust force protection bio-technology tools for Air Expeditionary Force commanders to assess chemical exposures and predict adverse human health and mission performance impacts.
- (U) \$ 94 Evaluate Photorefractive Keratectomy (PRK) as surgical method to reduce need for glasses or contact lenses for aircrew.
- (U) \$ 196 Identified as a source for SBIR.
- (U) \$12,147 Total

(U) FY 2000 (\$ in Thousands):

- (U) \$ 3,245 Conduct laser optical bioeffects research to enable countermeasures for optical hazards/threats by evaluating and exploiting laser glare and flashblindness bioeffects with and without laser eye protection, conducting high-energy laser reflection hazard analysis, developing probability-based methods of laser hazard analysis, and proposing tri-Service recommendations for High-Energy Laser system use policy and requirements for test range certification.
- (U) \$ 4,773 Conduct radio frequency bioeffects research to enable safe exploitation of lethal and non-lethal directed energy weapons and radar by providing updated DoD and exposure guidelines for ultra-wideband radiation and starting Air Expeditionary Force Agile Combat Support Initiative for portable High Energy Microwave Active Denial Technology.
- (U) \$ 550 Continue to evaluate Photorefractive Keratectomy as surgical method to reduce need for glasses or contact lenses for aircrew. Collect and analyze first year post operative data.
- (U) \$ 8,568 Total

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BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602202F Human Effectiveness Applied Research</b>	PROJECT <b>7757</b>
<p>(U) <u>FY 2001 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> <li>– (U) \$ 4,144     Conduct laser optical bioeffects research to enable countermeasures for optical hazards/threats by developing non-lethal laser use guidelines. Complete joint-Service personnel effects model to assess combat vulnerability to emerging optical threats and generate optical safety guidance for high energy laser test program.</li> <li>– (U) \$ 5,980     Conduct radio frequency bioeffects research to enable safe exploitation of lethal and non-lethal directed energy weapons and radar by continuing Air Expeditionary Force Agile Combat Support Initiative for portable High Energy Microwave Active Denial Technology and completing recommendation for DOD standard for High Power Microwave and ultra-wideband radiation weapons.</li> <li>– (U) \$    500     Continue Photorefractive Keratectomy as surgical method to reduce need for glasses or contact lenses for aircrew. Collect and analyze second year post operative data.</li> <li>– (U) \$10,624     Total</li> </ul> <p>(U) <b>B. <u>Project Change Summary - Description of Significant Changes:</u></b> Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&amp;T) Program.</p> <p>(U) <b>C. <u>Other Program Funding Summary:</u></b></p> <p>(U) <u>Related Activities:</u></p> <ul style="list-style-type: none"> <li>– (U) PE 0602720A, Environmental Quality Technology.</li> <li>– (U) PE 0602777A, Systems Health Hazard Prevention Technology.</li> <li>– (U) PE 0603231F, Crew Systems and Personnel Protection Technology.</li> <li>– (U) PE 0604706F, Life Support Systems.</li> <li>– (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.</li> </ul> <p>(U) <b>D. <u>Acquisition Strategy:</u></b> Not Applicable.</p> <p>(U) <b>E. <u>Schedule Profile:</u></b> Not Applicable.</p>		
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